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International application number: PCT/US05/003769

International filing date: 04 February 2005 (04.02.2005)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/541,996
Filing date: 04 February 2004 (04.02.2004)

Date of receipt at the International Bureau: 11 March 2005 (11.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

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APPLICATION NUMBER: *60/541,996*
FILING DATE: *February 04, 2004*
RELATED PCT APPLICATION NUMBER: *PCT/US05/03769*

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05909 U.S.PTO 020404

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
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☐ *Additional inventors are being named on the ___ separately numbered sheets attached hereto*

81355 U.S.PTO 60/541996 020404

TITLE OF THE INVENTION (280 characters max)

HYDRAULIC TORQUE WRENCH SYSTEM

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 7

☑ Drawing(s) *Number of Sheets* 2

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number

☑ Other (specify) Return Postcard

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check or money order is enclosed to cover the filing fees

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☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE AMOUNT ($) $160.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

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Date 02/ 04 / 04

REGISTRATION NO. *(if appropriate)* 31,356

Docket Number: 130324.00067

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

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HYDRAULIC TORQUE WRENCH SYSTEM

FIELD OF THE INVENTION

This invention relates to hydraulic torque wrenches, and in particular to pumps for and methods of controlling hydraulic torque wrench tightening operations.

DISCUSSION OF THE PRIOR ART

Conventional torque wrench pumps typically require the operator to advance and retract the torque wrench cylinder numerous times before final tightening of the fastener is achieved. The required torque set point is obtained by setting an adjustable system relief valve to a pressure setting that corresponds to the desired torque.

A typical sequence requires the operator to press and hold a button to advance the torque wrench cylinder, monitor both the system pressure and wrench cylinder position until it is fully extended, then release the button until the wrench cylinder is fully retracted. This interim tightening step must be repeated numerous times until the proper pressure (corresponding to the desired torque setting) is reached prior to full cylinder extension, indicating the proper fastener torque value has been achieved and the final tightening step completed. The entire process can be very tedious, time-consuming, and often necessitates the use of a second individual (one to monitor wrench position and one to monitor system pressure).

SUMMARY OF THE INVENTION

This invention provides a method and apparatus for precisely controlling and automating a hydraulic torque wrench fastener tightening system. In so doing, system pressure representative of the torque is obtained and is used to monitor the tightening of the fastener and determine a final stopping point for terminating tightening. The invention accomplishes this without adding any attachments to the hydraulic torque wrench.

By utilizing a system controller and system pressure feedback, the tightening (or loosening) process can be automated to substantially simplify operation, reduce cycle time and operator fatigue, and reduce personnel requirements. Such a sequence is

outlined in the following paragraphs, and essentially fully automates the interim tightening steps. The end result is a fastener that reaches a programmable torque set point in a minimal amount of time without continual manual operation of the advance and retract cycles.

The invention provides a hydraulic torque wrench fastener tightening system having a double acting cylinder that turns a socket of the wrench upon an advance of the cylinder and ratchets backward over the socket without turning the socket upon a retract of the cylinder in which, in response to an operator actuating an advance actuator and holding it actuated, the system alternately: (a) applies a pressure to the cylinder to advance the cylinder until a set pressure is reached; and (b) applies a pressure to the cylinder to retract the cylinder. A system of the invention does this in such that when a desired torque of the fastener is reached, the alternation cycle between processes (a) applying a pressure to the cylinder to advance the cylinder and (b) applying a pressure to the cylinder to retract the cylinder is reduced in duration. This reduction in duration indicates to the operator that the fastener has reached the desired torque, and may be indicated audibly, visually or both. In addition, the pump can be automatically turned off after the fastener has reached the desired torque.

These and other objects and advantages of the invention will be apparent from the detailed description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view illustrating the hydraulics and electronics of a hydraulic torque wrench system of the invention; and

Fig. 2 is a schematic block diagram of the system of Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Description of the Components

Torque Wrench

The wrench may be of any suitable type. One such type is shown, which is of a prior art design. The wrench is designed for extremely rugged and heavy-duty service, having a solid steel body which houses a sleeve and plug that define a hydraulic cylinder within the body. The piston is slidably received in the cylinder to reciprocate axially as hydraulic fluid is introduced to the cylinder at either the advance or return lines.

A fine-toothed spline drive ratchet pawl engages teeth on the outside of the quill shaft, which is journaled in the body to rotate the quill shaft clockwise on the advance stroke. The quill shaft drives a socket, which engages a head of a fastener to rotate and tighten (or loosen) the fastener. On the return stroke, the ratchet pawl chatters in reverse over the teeth of the shaft, preventing rotating of the socket and fastener. The full stroke of the cylinder typically corresponds to a fraction of a rotation, on the order of 20-30 degrees. Hence the process of fully tightening a fastener can require dozens of cylinder cycles.

Pump Unit

The pump unit consists of a fixed displacement pump, electrical motor, valve, pressure transducer, pendant and system controller incorporating a microprocessor.

Fixed Displacement Pump – electrical motor provides the motive force to a fixed displacement hydraulic pump.

Pendant –the primary interface for the operator, typically containing buttons to both turn the motor on and off as well as advance and retract the torque wrench cylinder.

Valve – a dual solenoid operated, four way, two position (4-2) valve which controls the porting of the hydraulic fluid through the system.

LCD Panel – displays system pressure and pump status, also incorporates buttons which allow the operator to perform tasks such as entering pressure or torque set points and cycle through display settings.

Pressure Transducer – measures system pressure upstream of the valve and provides feedback to the system controller; in addition to controlling the cycling set

points of the solenoid valves during normal system operation, it also acts as a relief valve for a "A" port by monitoring whether the upper limit set point has been reached.

System Controller - monitors operator inputs from the pendant, torque wrench pressure as measured by the transducer, and system status. The controller also controls the system operation and provides outputs to the display, the motor and to actuate the valve solenoids.

Sequence of Operation:

1. Operator enters maximum pressure into system controller via the LCD panel. The pressure set point is determined by the operator via a pressure to torque conversion table for the torque wrench in use.
2. Operator presses and releases the motor key on the pendant, which turns on the pump motor and energizes the B solenoid.
    - Flow from the pump is ported through the valve into the retract port of the torque wrench
    - Flow from the advance port on the torque wrench is ported through the valve into the pump reservoir.
    - The torque wrench cylinder retracts (if the cylinder is not in a fully retracted position), ratcheting along the quill shaft and leaving the fastener stationary.
    - The cylinder continues to retract until either the advance button is pressed or the internal pressure relief setting of the valve is reached, porting the pump flow to the pump reservoir.
    - If the advance button is not pressed within 10-20 seconds, the system controller will turn off the motor.
3. Operator presses the advance key on the pendent which energizes the A solenoid and de-energizes the B solenoid.
    - Flow from the pump is ported through the valve into the advance port of the torque wrench
    - Flow from the return port of the torque wrench is ported through the valve into the pump reservoir

- The torque wrench cylinder advances, engaging the quill shaft and causing the fastener to rotate.
- The cylinder continues to advance until either the advance button is released or the programmable pressure set point is reached.

The set point is reached one of two ways

1. The cylinder reaches full stroke, preventing further advancement, causing the hydraulic pressure to increase to the set point.
2. The cylinder is in mid stroke, however, the torque required to turn the fastener increases to the desired value, which causes the hydraulic pressure to increase to the set point.

4. With the advance button still pressed, once the pressure set point is reached, the system controller automatically retracts the wrench by de-energizing the A solenoid and energizing the B solenoid. The wrench retracts fully, causing the pump pressure to rise to a factory set point. The system controller then automatically advances the wrench by energizing the A solenoid and de-energizing the B solenoid.
5. Upon release of the advance button, the system controller will automatically fully retract the wrench, regardless of cylinder position or fastener torque. If the advance button is not pressed again within 10-20 seconds, the system controller will turn off the motor.

As long as the advance button remains pressed, the system controller will continue this automatic cycling of the wrench (between advance & retract). This saves operation time, as the operator no longer needs to manually identify the end of each advance & retract cycle. It also reduces operator fatigue, as the operator no longer needs to press & release control button(s) for each cycle.

When the torque required to turn the fastener increases to the desired value, additional automatic cycles (advance & retract) will be very short in duration due to lack of fastener movement. This shortened duration will be both audibly & visually apparent

to the operator that the fastener is at the desired torque. This saves operation time and reduces the personnel involved, since monitoring system pressure is no longer needed.

Potential additional programming features

Additional programming features can be added, incorporating items such as:

1) Automatic pump shut off when the fastener has reach the desired torque – the system controller measures the duration of each advance and retract cycle, and when the duration drops below a corresponding set point, the system controller turns the pump off.
2) Pre-programmed torque wrench types – this would allow an operator to select from a variety of existing torque wrench models that have torque to pressure conversion factors programmed into the system controller. In doing so, the operator could set the tightening (loosing) torque set point to a specific torque value without having to manually look up the conversion value or pressure equivalent. Alternatively, the operator could also manually input a torque to pressure conversion factor into the system controller for a specific wrench. In both these cases the equivalent torque value could also be displayed on the LCD display during system operation in lieu of pressure.

We Claim:

1. A hydraulic torque wrench fastener tightening system having a double acting cylinder that turns a socket of the wrench upon an advance of the cylinder and ratchets backward over the socket without turning the socket upon a retract of the cylinder in which, in response to an operator actuating an advance actuator and holding it actuated, the system alternately: (a) applies a pressure to the cylinder to advance the cylinder until a set pressure is reached; and (b) applies a pressure to the cylinder to retract the cylinder; such that when a desired torque of the fastener is reached the alternation cycle between processes (a) applying a pressure to the cylinder to advance the cylinder and (b) applying a pressure to the cylinder to retract the cylinder is reduced in duration and thereby indicates to the operator that the fastener has reached the desired torque.

2. A hydraulic torque wrench fastener tightening system as claimed in claim 1, wherein the process of (b) applying a pressure to the cylinder to retract the cylinder is terminated when a set pressure is reached.

3. A hydraulic torque wrench fastener tightening system as claimed in claim 1, wherein the indication to the operator that the fastener has reached the desired torque is an audible indication.

4. A hydraulic torque wrench fastener tightening system as claimed in claim 1, wherein the indication to the operator that the fastener has reached the desired torque is a visual indication.

5. A hydraulic torque wrench fastener tightening system as claimed in claim 1, wherein after the fastener has reached the desired torque the system shuts off a motor that drives a pump of the system after a certain time period following reaching the desired torque.

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Fig. 1

Smart Torque Wrench Concept

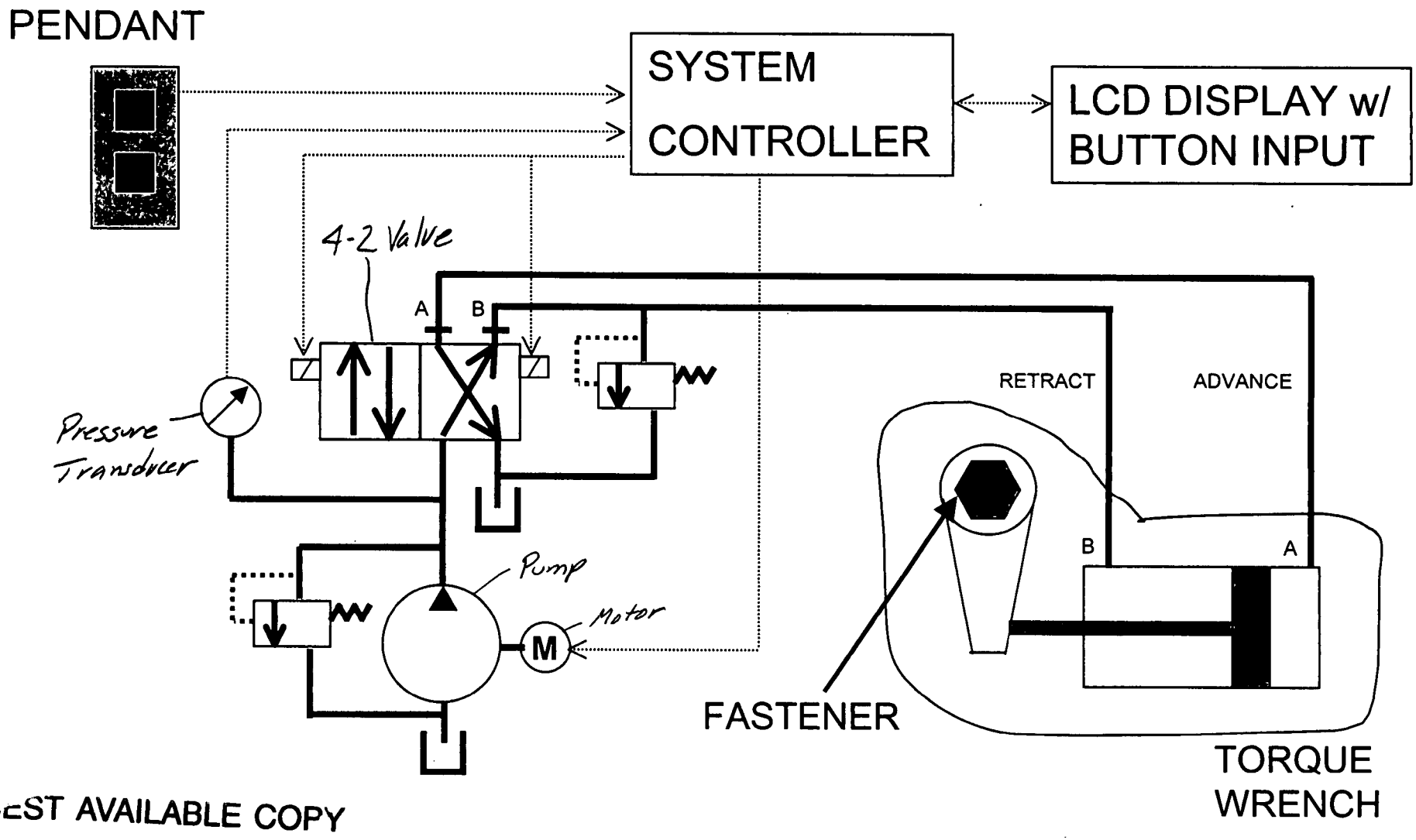

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Fig. 2

Smart Torque Wrench Concept